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(71) Applicant(s)
Daimler-Benz AG

(Incorporated in the Federal Republic of Germany)

Epplestrasse 225, D-70546 Stuttgart,
Federal Republic of Germany

(72) Inventor(s)
Ulrich Augustin

(74) Agent and/or Address for Service
Jensen & Son
70 Paul Street, LONDON, EC2A 4NA, United Kingdom

# (54) I.c. engine common rail fuel injection valve

(57) The injection valve has a nozzle housing 1 with an inlet passage 2 connected to a high pressure common rail; a branch passage 2a is connected to a control space 4. The pressure in the control space 4 acts on a control piston 3 which exerts force on the rear end of the nozzle needle shank 10. The control space is also connectible to a pressure relief line 8 by the opening of a pressure relief valve 7 actuated by electromagnet 9. The control piston 3 has a bore 16 enclosing a closing spring 17. If there is pressure in the inlet 2,2a, the control piston and the nozzle needle shank 10 contact each other directly so that the closing spring 17 is bypassed; the closing spring 17 comes into action only when the system is at rest, the service life of the spring 17 is thus extended. In modifications (figs.2,3) the spring is guided by a pin (fig.2) or a sleeve (fig.3) which acts as a spacer between the control piston 3 and the nozzle needle shank 10.

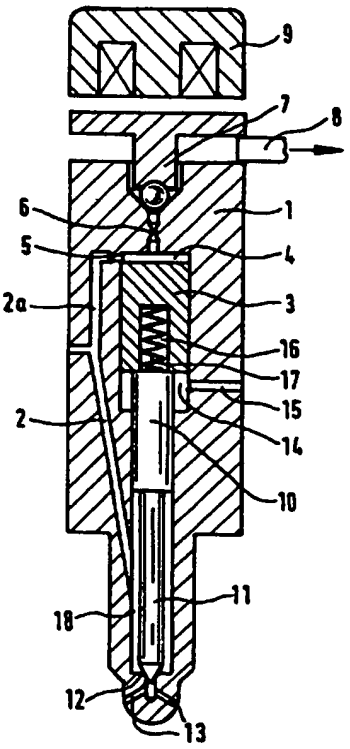


Fig. 1

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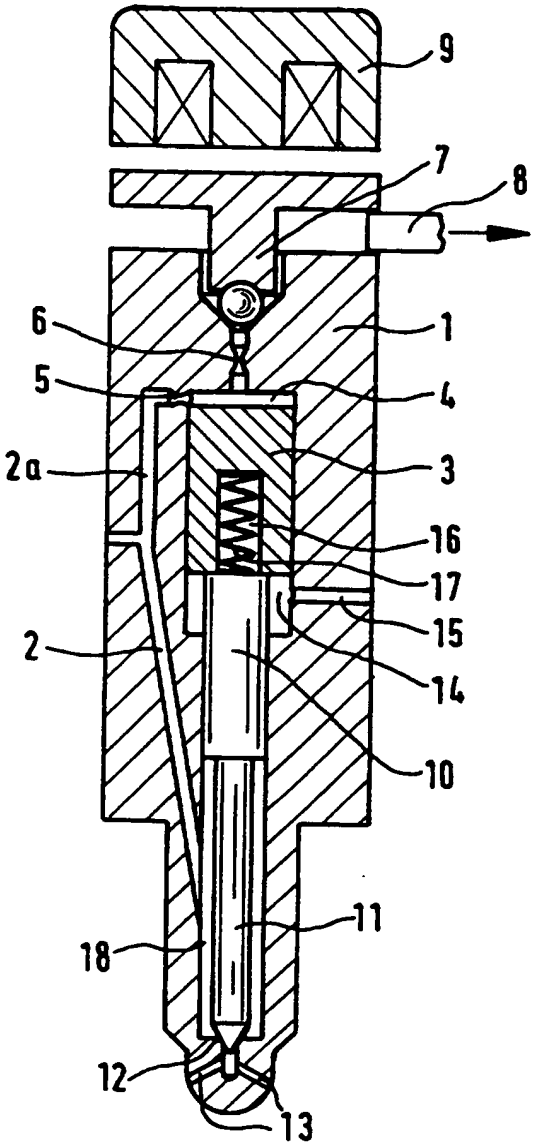


Fig. 1

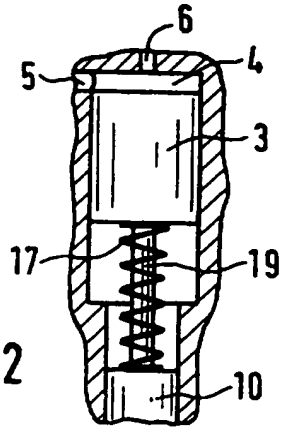


Fig. 2

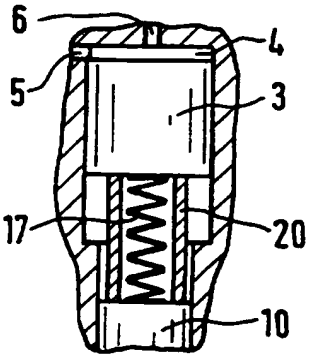


Fig. 3

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# Injection valve for internal combustion engines

The invention relates to an injection valve for internal combustion engines, the valve having a nozzle needle, with a pressure relief valve, a control space which is connected to an inlet line for fuel under pressure and is connected to a pressure relief line when the pressure relief valve is open, the fuel pressure in the control space acting, via a control piston, on the rear end of the nozzle needle, together with a nozzle-needle closing spring to urge said nozzle needle against a valve seat of the injection valve, the nozzle-needle closing spring being supported by one end against the rear end of the nozzle needle or an intermediate element connected to the nozzle needle.

An injection valve of this kind is described in EP 0 615 064 A1. It is also referred to as a "common rail injector". In this arrangement, the valve is subjected to high pressure even in the state of rest, i.e. in the state in which the nozzle needle is closed and there is no fuel injection. The nozzle needle is held in the closed position by the nozzle-needle spring, on the one hand, and by the pressurization of a control space, on the other, this control space being connected to the high-pressure inlet line. With the engine switched off, when there is no longer high pressure in the system, the nozzle-needle spring holds the nozzle needle in the closed position on its own, thereby preventing penetration of fuel into the cylinder space.

In operation, i.e. when fuel is to be injected, activation of an electromagnet ensures that the control space is connected to a pressure-relief line. By virtue of the pressure and diameter ratios given, the high pressure effects opening of the nozzle needle against the closing force of the nozzle-needle closing spring.

In the case of the injection valve disclosed in EP 0 615 064, the nozzle-needle closing spring is supported at one end on the rear end of the nozzle needle, while its other end is supported against a fixed part of the housing. The disadvantage with this previously known injection valve is that the nozzle-needle closing spring functions not only in the state of rest of the injection nozzle but also during operation, being subjected to continuous dynamic stress. This means that there is a corresponding susceptibility to faults, e.g. wear and a reduction in service life extending as far as breakage of the spring. Another disadvantage is that natural vibrations of the spring

may be established during operation, altering the fuel supply behaviour in a corresponding manner.

DE 38 24 467 A1 has described an injection valve for large engines. In this arrangement, the closing spring of the said valve can be preloaded to a greater or lesser extent by different pistons. Two pistons are provided for this purpose. The valve does not relate to a common-rail system. The nozzle needle is held in the closed position by a spring. A plurality of injection holes are furthermore provided, and these can be controlled independently of one another.

DE 38 11 885 C2 has disclosed an injection device with pilot and main injection and a spring-loaded piston. Overall, the injection device is of different construction and is not associated with the common-rail system.

DE 41 15 103 A1 has described an injection device with a high-pressure pump based on the common-rail system. The valve does not have a closing or control piston. This task is performed by a nozzle-needle shank.

The present invention seeks to provide an injection valve of the type mentioned at the outset which is of simpler construction and, in particular, less susceptible to faults.

According to the present invention there is provided a fuel injection valve for internal combustion engines, the valve having a nozzle needle, with a pressure relief valve, a control space which is connected to an inlet line for fuel under pressure and is connected to a pressure relief line when the pressure relief valve is open, the fuel pressure in the control space acting, via a control piston, on the rear end of the nozzle needle, together with a nozzle-needle closing spring to urge said nozzle needle against a valve seat of the injection valve, the nozzle-needle closing spring being supported by one end against the rear end of the nozzle needle or an intermediate element connected to the nozzle needle, and by its other end, against the control piston or against an intermediate element abutting or connected to the control piston, the arrangement being such that, in the open state of the nozzle needle, the nozzle needle is in positive connection with the control piston so that the nozzle needle closing spring is bypassed.

By means of the arrangement and design in accordance with the invention of the nozzle-needle closing spring, it is without effect in the operating state,

i.e. when the nozzle needle is open and fuel is injected into the associated cylinder space, and is therefore under no dynamic loading. By virtue f the bypassing of the nozzle-needle closing spring, the control piston acts directly and in a mechanical way on the nozzle needle. The nozzle-needle closing spring according to the invention is used or comes into operation virtually only when it is required, namely in the state of rest of the injection valve, in order to prevent fuel from flowing out into the cylinder space. In all other cases, i.e. when there is pressure in the system, it is motionless.

A further advantage of the solution according to the invention is that, given this configuration of the injection nozzle, the overall length is relatively short since the nozzle-needle closing spring is arranged in a space-saving manner between the control piston and the nozzle needle. In comparison with prior-art solutions, the solution according to the invention also eliminates sealing surfaces and the injection nozzle is of simple construction, leading to a corresponding saving in costs.

Advantageous configurations and developments of the invention can be found in the exemplary embodiments described below with reference to the drawing, in which:

Figure 1 shows a diagrammatic representation of the injection nozzle according to the invention, in longitudinal section;

Figure 2 shows a detail of an injection nozzle with a different arrangement of the nozzle-needle closing spring; and

Figure 3 shows a detail of an injection nozzle with a third arrangement of the nozzle-needle closing spring.

The injection valve described below is fundamentally of known design as regards its construction and mode of operation (see, for example, EP 0 615 064 A1), for which reason only those parts which are essential to the invention are described in greater detail.

The injection valve has a nozzle housing 1 with an inlet passage 2 which is connected to a common-rail system under high pressure. A control piston 3 with a control space 4, which is situated behind the control piston 3, is arranged in a bore in the nozzle housing 1. The control space 4 is connected to the fuel, which flows in under high pressure, via a branch conduit 2a with a restriction 5. The control space 4 is furthermore connected to a pressure relief line 8 via an outlet restriction 6, which

can be closed by means of a solenoid valve 7 in the form of a two-way valve. The solenoid valve 7 can be actuated in a known manner by an electromagnet 9. Given an actuation of the solenoid valve by the electromagnet 9 and the resulting opening of the outlet restrictor 6, the control space 4 can in this way be relieved of pressure.

By virtue of the pressure in the control space 4, the control piston 3 exerts a force on the rear side of a nozzle-needle shank 10 of a nozzle needle 11. If it is not in the closed position, in which it rests on a valve seat 12 in the nozzle housing 1, the nozzle needle 11 exposes injection passages 13 leading to a cylinder space (not shown).

An annular space 14 which adjoins the control piston 4 on its side facing the nozzle needle 11, is connected to a fuel return for the purpose of discharging leakage fuel via a leakage line 15.

The control piston 3 is provided with a central blind bore 16 which is open towards the nozzle needle 11. Arranged in the bore 16 is a nozzle-needle closing spring 17. The nozzle-needle closing spring 17 has a size and length such that, in the compressed state, in the presence of high pressure in the inlet passage 2 and the branch line 2a, it is accommodated completely in the bore 16.

As can be seen from Fig. 1, the end of the control piston 3 facing the nozzle needle 11 rests directly against a rear end of the nozzle-needle shank 10.

The injection valve according to the invention now functions in the following manner:

In operation, i.e. in the presence of a continuously applied system pressure, the nozzle-needle closing spring 17 is bypassed. The control piston 3 and the nozzle-needle shank 10 rest directly against one another. Depending on whether the solenoid valve 7 is holding the outlet restrictor 6 in the open or closed position by virtue of the electromagnet 9, the nozzle needle 11 is in the open or closed state in a known manner. Only in the state of rest, when there is no high pressure in the inlet passage 2 and hence also in the branch passage 2a, does the nozzle-needle closing spring 17 come into action. By virtue of the absence of counterpressure on a high-pressure space 18 from which the injection openings 13 emanate, the spring force in this case acts on the rear end of the nozzle-needle shank 10 and hence presses the nozzle needle 11 onto the valve seat 12.

In the exemplary embodiment shown in Fig. 2, the nozzle needle 11 is fundamentally of identical construction to that described in Fig. 1. Instead of a bore 16 in the control piston 3, a pin 19 is provided as a guide member to provide guidance and also to provide a direct mechanical connection or direct contact between the control piston 3 and the nozzle-needle shank 10 during operation. The nozzle-needle closing spring 17 is laid around the pin 19 and guided by it.

Fig. 3 shows an equivalent solution as regards the guidance of the nozzle-needle closing spring 17. Instead of a pin 19 as the guide element, a sleeve 20 is provided here. The sleeve 20 is arranged as a spacer, like the pin 19, between the control piston 3 and the rear end of the nozzle-needle shank 10. The pin 19 shown in Fig. 2 and the sleeve shown in Fig. 3 are connected either to the control piston 3 or the nozzle-needle shank 10. In operation, the sleeve 20, like the pin 19, rests by its end against the other part respectively, i.e. either against the control piston 3 or the nozzle-needle shank 10 - depending on which of these it is connected to. This means that the nozzle-needle closing spring 17 is bypassed or ineffective in this state, and this applies also in the cases shown in Figs. 2 and 3. Only in the absence of high pressure in the system does the spring force between the control piston 3 and the nozzle-needle shank 10 become effective, thereby pressing the nozzle needle 11 onto the valve seat 12.

## Claims

1. A fuel injection valve for internal combustion engines, the valve having a nozzle needle, with a pressure relief valve, a control space which is connected to an inlet line for fuel under pressure and is connected to a pressure relief line when the pressure relief valve is open, the fuel pressure in the control space acting, via a control piston, on the rear end of the nozzle needle, together with a nozzle-needle closing spring to urge said nozzle needle against a valve seat of the injection valve, the nozzle-needle closing spring being supported by one end against the rear end of the nozzle needle or an intermediate element connected to the nozzle needle, and by its other end, against the control piston or against an intermediate element abutting or connected to the control piston, the arrangement being such that, in the open state of the nozzle needle, the nozzle needle is in positive connection with the control piston so that the nozzle needle closing spring is bypassed.

2. An injection valve according to Claim 1, wherein the nozzle-needle closing spring is arranged in a bore in the control piston, the said bore being open towards the nozzle needle.

3. An injection valve according to Claim 1, wherein at least one guide element for the nozzle-needle closing spring is arranged between the control piston and the nozzle needle, the guide element being connected either to the control piston or to the nozzle needle.

4. An injection valve according to Claim 3, wherein the guide element is a central pin on which the nozzle-needle closing spring is guided.

5. An injection valve according to Claim 3, wherein the guide element is a sleeve in the interior of which the nozzle-needle closing spring is guided.

6. An injection valve according to any one of claims 1 to 5, wherein the pressure relief valve is operable by an electro-magnet.

7. A fuel injection valve for internal combustion engines, substantially as described herein with reference to, and as illustrated in, the accompanying drawing.

The Patent Office

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**Application No:** GB 9717464.3 **Examiner:** John Twin
**Claims searched:** 1 to 7 **Date of search:** 13 November 1997

## Patents Act 1977
## Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F1B (B2JCB)

Int Cl (Ed.6): F02M 47/02

Other:

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | Relevant to claims |
|---|---|---|
| A | EP 615064 A1 (Ganser-Hydromag) | |

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